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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :
H04R 25/00, H04B 1/38
H04R 1/46, H04M 1/05

A1

(11) International Publication Number: WO 94/10818

(43) International Publication Date: 11 May 1994 (11.05.94)

(21) International Application Number: PCT/NL93/00228

(22) International Filing Date: 2 November 1993 (02.11.93)

(30) Priority data:
9201904 2 November 1992 (02.11.92) NL
93202890.5 13 October 1993 (13.10.93) EP
(34) Countries for which the regional or international application was filed: AT et al.

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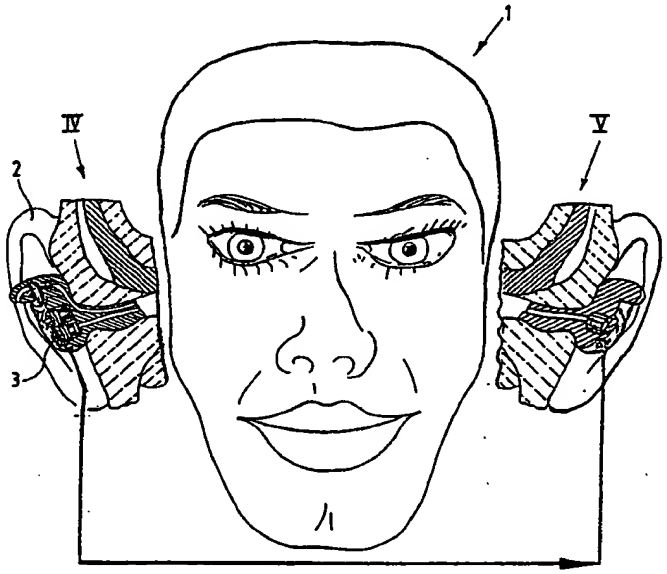
(81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.
In English translation (filed in Dutch).

(54) Title: SOUND AMPLIFICATION SYSTEM



(57) Abstract

The invention relates to a personal sound amplification system for being carried by a user comprises a microphone, a loudspeaker and an amplifier having an input connected to the microphone and an output connected to the loudspeaker. The invention now provides a system having the feature that the microphone is incorporated in an ear-piece which is adapted for positioning in the ear canal of the one outer ear of a user such that the microphone can pick up sound from this ear canal; and the loudspeaker is adapted for positioning in the region of the other outer ear of the user and for generating sound thereto.

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SOUND AMPLIFICATION SYSTEM

The invention relates to a personal sound amplification system for carrying by a user, comprising:

a microphone;

a loudspeaker; and

an amplifier having an input connected to the microphone and an output connected to the loudspeaker. Such a sound amplification system is known. It is used by people with impaired hearing in order to amplify the incoming sound and to feed it to the impaired ear in amplified form.

Also known is a so-called headset used in telecommunications and for other purposes. Such a headset comprises a combination of one or two loudspeakers which are placed in the vicinity of one or both ears and a microphone normally for placing in the vicinity of the mouth of the wearer.

A headset of this type has a number of drawbacks. The use of a microphone at the mouth is usually perceived as unpractical since it restricts the freedom of the user. In addition, popping sounds due to the occurring air flows cannot always be prevented from occurring. In the use of a normal microphone or a directional microphone the known system is sensitive to ambient noise. The use of a noise cancelling microphone has the drawback that this must be worn very close to the mouth and must be spoken into very loudly. There is a general inability to control the output signal. As a result a user may tend to start speaking unnecessarily loudly.

The invention has for its object to bring about an improvement in the placing of the microphone, in picking up of an individual voice and controlling of the output sound signal.

The invention now provides a system of the type stated in the preamble having the feature that the microphone is incorporated in an ear-piece which is adapted for positioning

in the ear canal of the one outer ear of a user such that the microphone can pick up sound from this ear canal; and

the loudspeaker is adapted for positioning in the region of the other outer ear of the user and for generating sound thereto.

By thus providing the voice sound picked up in the one ear and amplified as required to the other ear there results a feedback to the brain with which it has been found possible to make the output voice signal formation precisely controllable in terms of volume and sound. Insofar as this involves the use of a headset, a signal derived herefrom can then also form the output signal of the headset. The output signal can be supplied at a sound pressure level such that it can be anticipated that the loudness sensation of the receiver corresponds substantially with that of the wearer himself. An incoming signal can then be listened to more loudly than usual. In combination with the clearly audible own voice this offers possibilities for use by the hard of hearing. Because the microphone can now be well shielded from ambient noise the system according to the invention can also be applied very effectively in a noisy environment. It has been found generally that it is already possible to communicate well when speaking very softly.

The ear-piece can be adapted to the specific form of the ear canal of a user or be of more or less universally applicable type, in which latter case use is preferably made of elastically deformable material.

The microphone can be completely sealed by the ear-piece in relation to the environment and substantially only pick up sound via the ear canal. In some conditions it may be desirable to limit this complete isolation somewhat. Under most conditions it is desirable that a pressure equalization can take place over the ear-piece. It can also be advantageous for particular types of sound or frequencies/frequency bands to be transmitted selectively or suppressed. Sound can if desired also be transmitted with the said frequency selectivity using electro-acoustic means. Use can be made for this purpose of a separate

microphone/amplifier/loudspeaker system. It is noted that it is known per se to use a narrow passage as sound damper.

The loudspeaker can also be adapted such that it substantially seals the other ear completely. In this way little or no direct sound can penetrate to that ear. Use can also be made here of a passage adjustable as desired, whereby the relevant ear can also be in direct acoustic contact with the environment. For use in combination with a headset use can be made if desired of a second loudspeaker which transmits incoming audio signals directly to the relevant ear. Such signals can however also be transmitted directly to the first loudspeaker so that it is possible to suffice with one loudspeaker.

In a particular embodiment the system according to the invention is characterized by signal processing means arranged in the signal path between the microphone and the loudspeaker such as a filter, an equalizer, a compressor, a limiter, a noise suppressor, means for preventing howl. The ambient noise which may still penetrate in undesired manner can be effectively reduced in different ways. The ear-piece can be provided with means to improve the sealing. Use can also be made of electronic, for instance active, sound suppression, in which latter case use is made of sound supplied in counter-phase.

Using such means, particularly filters and equalizers, the best possibility audibility can be realized. A compressor and a limiter can serve to protect the relevant ear from too high sound pressure levels. A noise suppressor can considerably increase comfort. With such a system amplification only takes place in the presence of a speech signal. Reference is made in this respect to the existence of a very rapidly and inaudibly operating speech switch commercially available under the trade name "Voicematic" from the US firm Industrial Research Products.

In the case of a high amplification factor, for instance in the case of users with impaired hearing, the use of means to prevent howl can be recommended.

The amplification factor of the amplifier can preferably be adjustable. The same applies to the signal processing means.

For particular applications, for instance for telecommunication purposes, the system can have the special feature that the microphone and the loudspeaker are fixed to a bracket such that the microphone can be worn by the one outer ear of the user and the loudspeaker by the other outer ear.

In noisy conditions the system can be embodied such that the microphone and the loudspeaker are shielded by respective ear protection covers.

In a specific embodiment the system has the feature that the signal coming from the microphone is sent via a radio transmitter to a receiver worn by a user or a third party, the output signal of which is supplied to the loudspeaker. It is noted in this respect that when more than one of the same systems of this type are used, the various users can communicate with each other extremely well even in noisy conditions.

In particular when used as headset the system according to the invention can advantageously be characterized by an external signal output connected to the output of the amplifier in addition to an external signal input which is connected to the loudspeaker.

It can be advantageous in noisy conditions to suppress as much ambient noise as possible. In particular in conditions where a large portion of low frequency noise is present the system according to the invention can be characterized by a second microphone which is placed such that it can substantially only pick up ambient sounds; and

a difference amplifier whereof the two inputs are connected to the two microphones, the output of which difference amplifier is connected to the loudspeaker.

This system is preferably characterized by delay means or phase shifting means arranged in the signal path between the second microphone and the difference amplifier.

In order to prevent howl there are, in the context of public address systems, a number of usually complicated

systems. Such systems normally comprise voltage-controlled amplifiers, limiters, periodicity detectors and the like. According to the invention the signal processing means can comprise a circuit which interrupts or damps the signal path when the microphone signal exceeds a predetermined value. This solution is based on the insight that in normal conditions the microphone signal can never exceed a determined value. At the moment that this nevertheless happens, it can only be the result of the fact that a situation of instability or howl is occurring.

The invention makes use of the fact that the microphone positioned according to the invention can pick up frequencies to above 3 kHz from the individual voice, which is more than sufficient in respect of the desired speech audibility. It has also been found that the generated sound pressure at the position of the microphone is more than adequate for the intended application in the context of the invention.

The invention is applied most advantageously in surroundings, which may or may not be noisy, in which the speaker has difficulty in hearing his own voice when the ears are closed off, whereby he loses control over his own voice. In the case of telecommunication it is then not clear to the speaker how his voice reaches the listener. The desire to speak very softly for reasons of privacy will in principle cause the same problem.

The user could wish to monitor two signals. The first signal relates to the voice formation, type S. The second signal relates to verification of that which (in the case of a headset) is transmitted, type V.

When an open microphone is used in front of the mouth as according to the prior art, these two types have a substantially fixed relation. Type S thereby provides an adequate frame of reference in the case of conventional communication terminals. This type S is implicitly present with the normal telephone receiver:

1. outward via the free ear,

2. inward (bone conduction, followed by radiation into the ear canal) via the free ear,

3. inward into the shielded ear (amplified by the reflection and the sealing of the receiver on the auricle).

Aspects 2 and 3 also apply to existing headsets.

Problems occur when on the one hand headsets are placed more closely onto the ear (in which case less space remains, which results in a decreased share in the low frequency spectrum and a reduced loudness), or even in the ear canal, and on the other hand are used in noisy surroundings or in the case of a very soft individual voice sound.

With this kind of terminal S must be effected in another way and the relation between type S and type V must be newly selected or adjusted.

The invention relates essentially to the manner in which S can be effected when the ears are sealed off "in the ear". The invention also describes that S and V are linked and controlled via S.

In the case of sealing "on the ear" this system works less well because the fed-back signal is mixed with too many signals transmitted via the biological structures. In this case the direct link between S and V is lacking.

It is often the wish of a user not to be completely cut off acoustically from the environment. In this respect the system has in a particular preferred embodiment the special feature that a pressure equalizing channel extends through the ear-piece.

A certain damping, possibly combined with a certain frequency selectivity, is often required. For this purpose the system can have the special feature that the pressure equalizing channel has a restriction.

In order to improve the insulation from ambient noise in extremely noisy conditions the system is characterized in a variant by an adjusting element controllable by a user with which the channel can be closed and opened.

To make the microphone accessible for possible service purposes the system may have the special feature that the microphone is accommodated removably in the ear-piece.

In order to experience very little disturbance from the ambient sound in noisy surroundings the system according to the invention can have the special feature that the

loudspeaker is arranged in an ear-piece which is adapted for positioning in the ear canal of the other outer ear of a user.

The invention will now be elucidated with reference to the annexed drawing, in which:

figure 1 shows a highly schematic embodiment of the system according to the invention;

figure 2 shows another embodiment;

figure 3 shows partly in front view, partly in cross section a practical embodiment of the invention;

figures 4 and 5 show details IV and V of figure 3 on a larger scale;

figure 6 shows a block diagram of the system according to the figures 3, 4 and 5;

figure 7 is a front view of a possible practical embodiment of the system;

figure 8 is a view corresponding with figure 7 of a variant;

figure 9 is a partly broken away perspective view of an ear-piece;

figure 10 is a schematic illustration, partly in the form of an electrical block diagram, of a system according to the invention;

figures 11-15 show partial side views and partial lengthwise sections through different embodiments of an ear-piece; and

figure 16 shows partly in front view, partly in cross section a cordless variant.

Figure 1 shows a user 1 who is wearing a sound amplification system according to the invention. This system comprises a microphone 3 worn in the one ear 2 and a loudspeaker 5 worn on the other ear 4. The microphone is connected to an adjustable amplifier 6 which supplies its output signals via a signal processing unit 7 to loudspeaker 5. The signal processing unit 7 may comprise one or more of for instance the following circuits: a filter, an equalizer for setting the frequency response as desired, a compressor, a limiter, a noise suppressor, means for suppressing howl.

It is noted that microphone 3 is only shown very schematically. According to the invention it is arranged in the ear canal of the ear 2 as will be described hereinbelow with reference to, among others, figures 3, 4 and 5.

Figure 2 shows a more extensive system. Here the loudspeaker is controlled via an adder circuit 8, of which the one input is connected to signal processing unit 7 and the other input receives feed of external input signals via a controllable amplifier 9. This system according to figure 2 can serve for instance as headset for telecommunication purposes.

Figure 3 shows a practical embodiment. For the sake of clarity reference is also made to figures 4 and 5. An ear-piece 10 fits sealingly in the ear canal 11 of the ear 2. The microphone 3 picks up sound from the ear canal 11 via a tube 12. A second microphone 15 does not pick up any sound from ear canal 11 but is adapted and placed to pick up substantially only ambient sound via an opening 27. In this way the second microphone 15 detects substantially only sound from the environment, while the first microphone 3 detects substantially only sound from the ear canal.

A second tube 13 connects to the environment the end of the ear-piece 10 placed in the ear canal 11. A rotatable adjusting member 14 can be rotatably mounted in ear-piece 10 and serves for selective closing or opening of tube 13. In this manner the user can as desired make his isolation relative to the environment as great as possible, which is required particularly in excessively noisy conditions, and reduce his isolation. Arranged in the tube 13 is a restriction 28 which acts as acoustic damper and also brings about a certain frequency selectivity.

Attention is drawn to the fact that the microphone 3, and if necessary also the second microphone 15, can be suspended in comparatively loose manner in the ear-piece 10. Less inconvenience hereby results from movements of this ear-piece 10, for instance also if pulling forces are applied to the connecting cord 29.

Figure 6 shows the manner in which the microphones are mutually connected for feeding signals to the loudspeaker 5.

The output signal from microphone 15 passes through an adjustable circuit 16 which can cause a delay or phase shift. The output of this circuit is connected to the one input of a difference amplifier 17, the other input of which is connected to microphone 3. Correct setting can bring about an effective suppression of ambient noise. The output signal of the difference amplifier 17 is fed to the amplifier 6 which feeds its signals via the adder circuit 8 to the loudspeaker 5. This latter part of the signal path can otherwise take a form identical to the corresponding part according to figure 2. In figure 6 a number of components have been omitted for the sake of clarity.

Figure 5 shows that the loudspeaker 5 can also be accommodated in an ear-piece, wherein the loudspeaker 5 can generate its sound via a tube 19. If desired use can also be made here of an extra tube which, similarly to figure 4, can transmit sound from outside by means of an adjustable passage directly to the ear canal 20. If desired the loudspeaker 5 can also be worn at a distance from the debouchment of the ear canal.

Figure 7 shows that the system of the invention can have a "walkman"-like construction. In this embodiment the diverse electrical and electronic units are accommodated in a unit 21 for carrying in a pocket.

Figure 8 shows a variant. The unit 22 is provided like the unit 21 with a clip 23 for fitting to clothing, for instance for carrying in a pocket.

Figure 9 shows a more or less universally applicable and therefore inexpensive ear-piece which can be used in the system according to the invention. This ear-piece 24 accommodates the microphone(s) or the loudspeaker. The protrusion 25 for insertion into the ear canal carries a flexible outer layer 26. With this flexible jacket a good adaptation to the ear of the user can be obtained.

It is noted that, in the context of telecommunication channels, the system is suitable without problem for both simplex and duplex connections.

Figure 10 shows in partly block-schematic and further generally schematic form an embodiment of a complete system

according to the invention. Components corresponding with above discussed components are designated with the same reference numerals as above.

Figure 10 shows the manner in which the microphone 15 operates to suppress ambient noise. The signal path from the microphone 15 via the adjustable amplifier 16 and the difference amplifier 17 to the amplifier 6 provides active compensation for lack of sealing of the ear-piece 10 in the ear canal 11. Thus obtained is an active compensation for acoustic leakage. The amplifier 6 can be regulated for adjustment as desired by the user of the volume at which he senses his own voice.

The microphone 15 further generates signals to an amplifier 41 with adjustable amplification. The automatic amplification control is embodied such that the amplification factor decreases as the volume of the signal from microphone 15 increases. The output signal of amplifier 41 is combined by an adder circuit 42 with the output signal of the adder circuit 18 to be supplied jointly to loudspeaker 5.

Figures 11-15 show different embodiments of an ear-piece in which a microphone is arranged.

The ear-piece 43 of figure 11 comprises an ear canal part 44, and a recess 45 present therein which can receive sound via channel 12. Microphone 3 is arranged in the recess 45. Via a seal 46 the part 44 is covered by a cover plate 47 in which the second microphone 15 is accommodated. This receives ambient sound via the opening 27. By means of screws 48 the ear-piece 43 is assembled to an integrated unit. In the figures 12-15 functionally similar components are designated with the same reference numerals as in figure 11. A connecting cable 52, relieved of pulling forces, is connected to the cover part 47.

Figure 12 shows an ear-piece 49 with a recess 50. The microphone is held in place by means of a plug of filling and damping material 51.

Figure 13 shows a variant wherein microphone 3 is accommodated in a recess 53 in the cover part 47. In this embodiment the sealing plate 46 has a hole 54 for passage of sound from the channel 12 to microphone 3.

Figure 14 shows a variant wherein via a connecting piece 55 the microphone 3 is placed between the seal 46 and the cover part 47. This simplifies repair by replacement of components.

Figure 15 shows a variant of the embodiment according to figure 13. In this embodiment the ear canal part 44 has a pressure equalizing channel 33. By means of a rotatable control member 56, in which is arranged a passage 57 with a restriction, pressure equalization and a certain frequency selectivity can be adjusted as desired by the user.

Figure 16 shows an embodiment wherein use is made of a radiographic cordless transmission. For this purpose the user 1 wears in his left ear 2 a microphone unit 58 which can have a construction corresponding with that of the above discussed microphone units. It is however further provided with a transmitter whereby the microphone signal can be transmitted in radiographic form.

In the right ear 4 the user wears a loudspeaker unit 59 which can in principle be embodied the same as the above described loudspeaker units, but which also comprises a receiver which is suitable for receiving the radio signal transmitted by microphone unit 58 and converting same into a signal suitable for driving the built-in loudspeaker.

The electrical supply for the units 58 and 59 can take place by means of a modern small (rechargeable) battery. The system according to figure 16 has a number of advantages. It can be worn practically invisibly since it can if desired take a cordless form. In addition a second user can wear a substantially identical system, whereby two users who are tuned with their systems to the same frequency can also communicate well in noisy conditions. Needless to say, in principle the system thus allows of unlimited addition.

Conceivable as a variant (not drawn) is a mixed embodiment, wherein the user himself wears a system for instance as according to figure 7 but can communicate with other users via a transmitter and receiver accommodated in the unit 21.

*****

CLAIMS

1. Personal sound amplification system for carrying by a user, comprising:

a microphone;

a loudspeaker; and

an amplifier having an input connected to the microphone and an output connected to the loudspeaker;

characterized in that

the microphone is incorporated in an ear-piece which is adapted for positioning in the ear canal of the one outer ear of a user such that the microphone can pick up sound from this ear canal; and

the loudspeaker is adapted for positioning in the region of the other outer ear of the user and for generating sound thereto.

2. Sound amplification system as claimed in claim 1, **characterized by** signal processing means arranged in the signal path between the microphone and the loudspeaker such as a filter, an equalizer, a compressor, a limiter, a noise suppressor, means for preventing howl.

3. Sound amplification system as claimed in claim 1, **characterized in that** the amplification factor of the amplifier is adjustable.

4. Sound amplification system as claimed in claim 2, **characterized in that** the signal processing means are adjustable.

5. Sound amplification system as claimed in claim 1, **characterized in that** the microphone and the loudspeaker are fixed to a bracket such that the microphone can be worn by the one outer ear of the user and the loudspeaker by the other outer ear.

6. Sound amplification system as claimed in claim 5, **characterized in that** the microphone and the loudspeaker are shielded by respective ear protection covers.

7. Sound amplification system as claimed in claim 1, **characterized in that** the signal coming from the microphone is sent via a radio transmitter to a receiver worn by a user or a third party, the output signal of which is supplied to the loudspeaker.

8. Sound amplification system as claimed in claim 1, **characterized by** an external signal output connected to the output of the amplifier in addition to an external signal input which is connected to the loudspeaker.

9. Sound amplification system as claimed in claim 1, **characterized by**

a second microphone which is placed such that it can substantially only pick up ambient sounds; and

a difference amplifier whereof the two inputs are connected to the two microphones, the output of which difference amplifier is connected to the loudspeaker.

10. Sound amplification system as claimed in claim 9, **characterized by** delaying or phase shifting means arranged in the signal path between the second microphone and the difference amplifier.

11. Sound amplification system as claimed in claim 2, **characterized in thatthe** signal processing means comprise a circuit which interrupts or damps the signal path when the microphone signal exceeds a predetermined value.

12. Sound amplification system as claimed in claim 1, **characterized in that** a pressure equalizing channel extends through the ear-piece.

13. Sound amplification system as claimed in claim 12, **characterized in that** the pressure equalizing channel has a restriction.

14. Sound amplification system as claimed in claim 12, **characterized by** an adjusting element controllable by a user with which the channel can be closed and opened.

15. Sound amplification system as claimed in claim 1, **characterized in that** the microphone is accommodated removably in the ear-piece.

16. Sound amplification system as claimed in claim 9, **characterized in that** the loudspeaker is arranged in an ear-

piece which is adapted for positioning in the ear canal of the other outer ear of a user.

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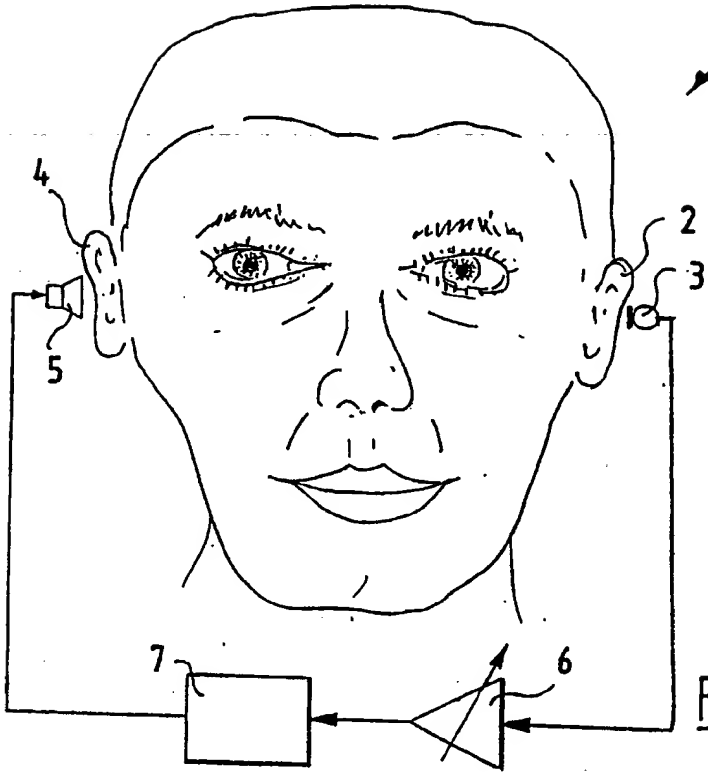

FIG.1

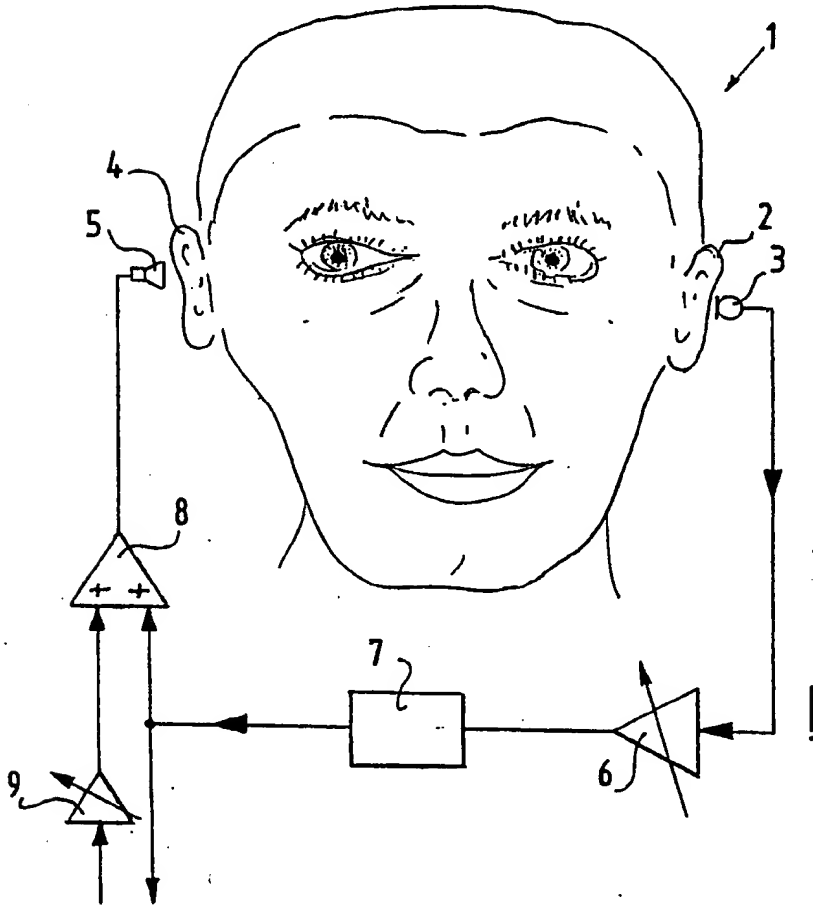

FIG.2

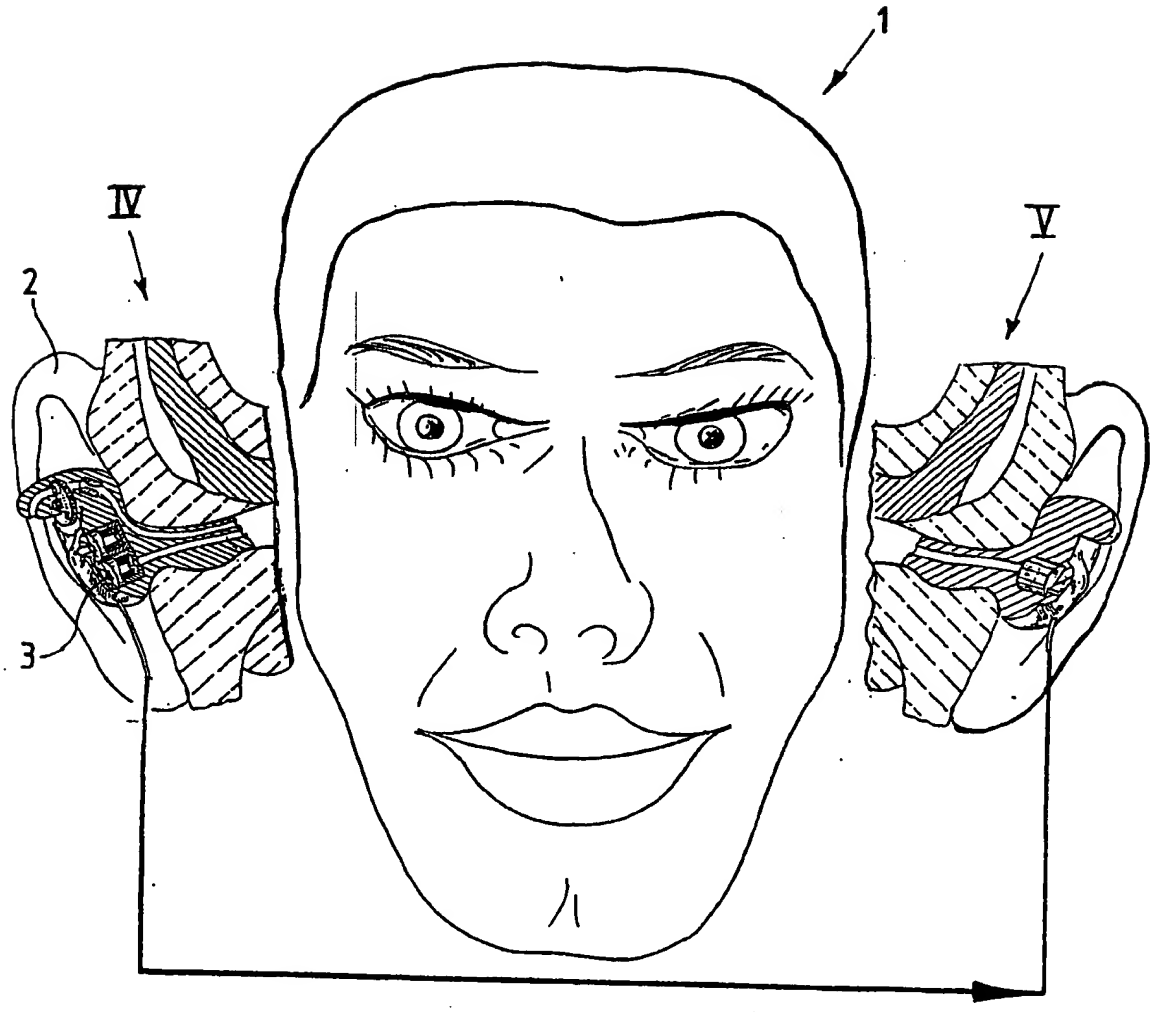

FIG.3

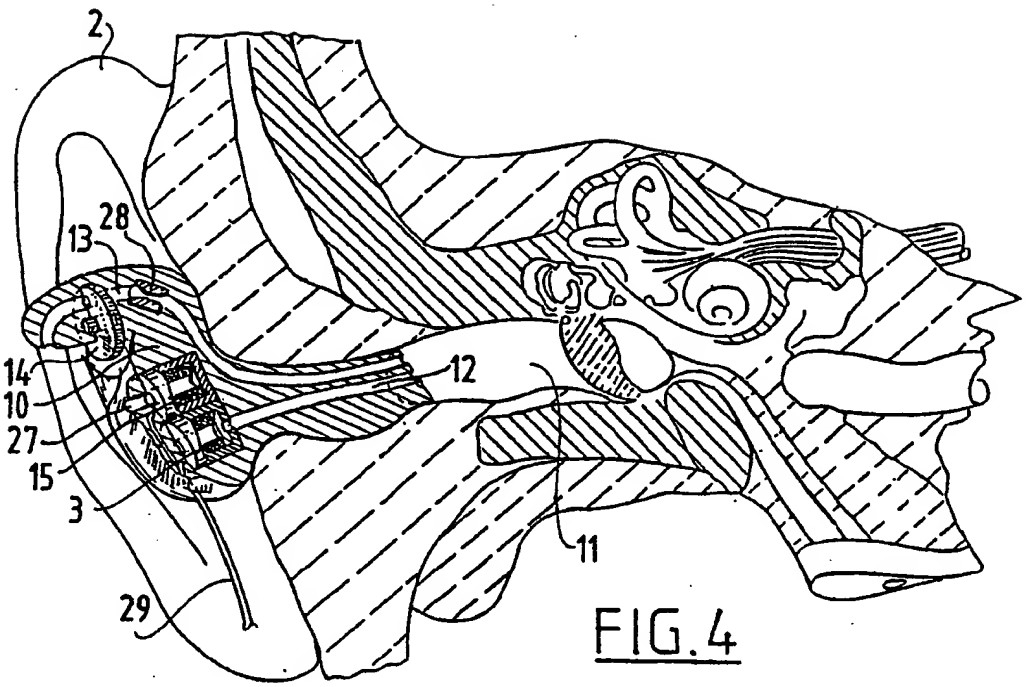

FIG.4

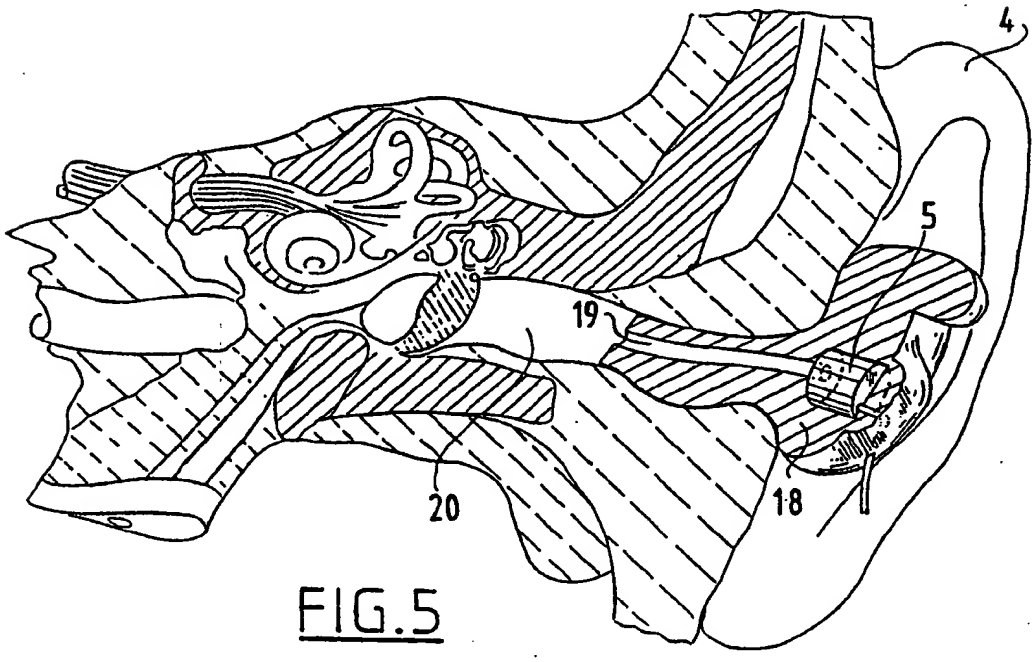

FIG.5

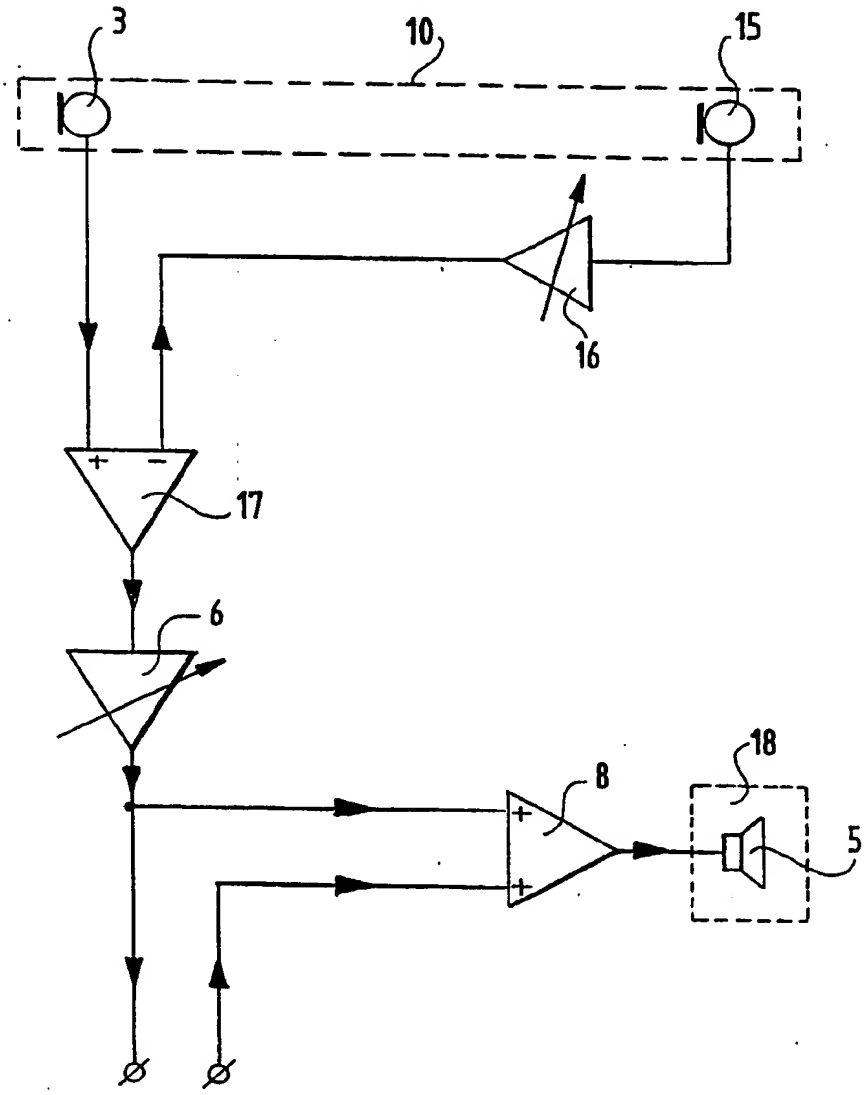

FIG.6

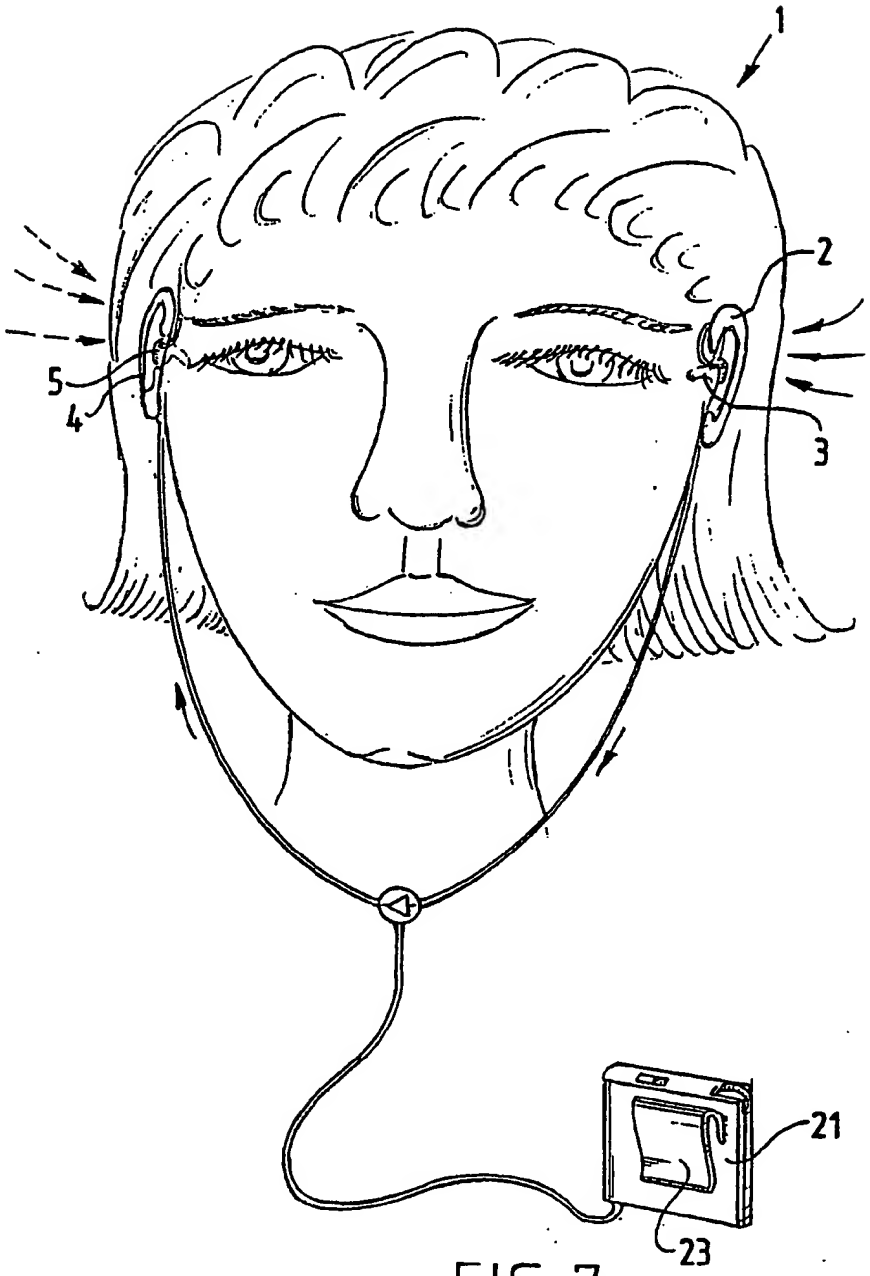

FIG. 7

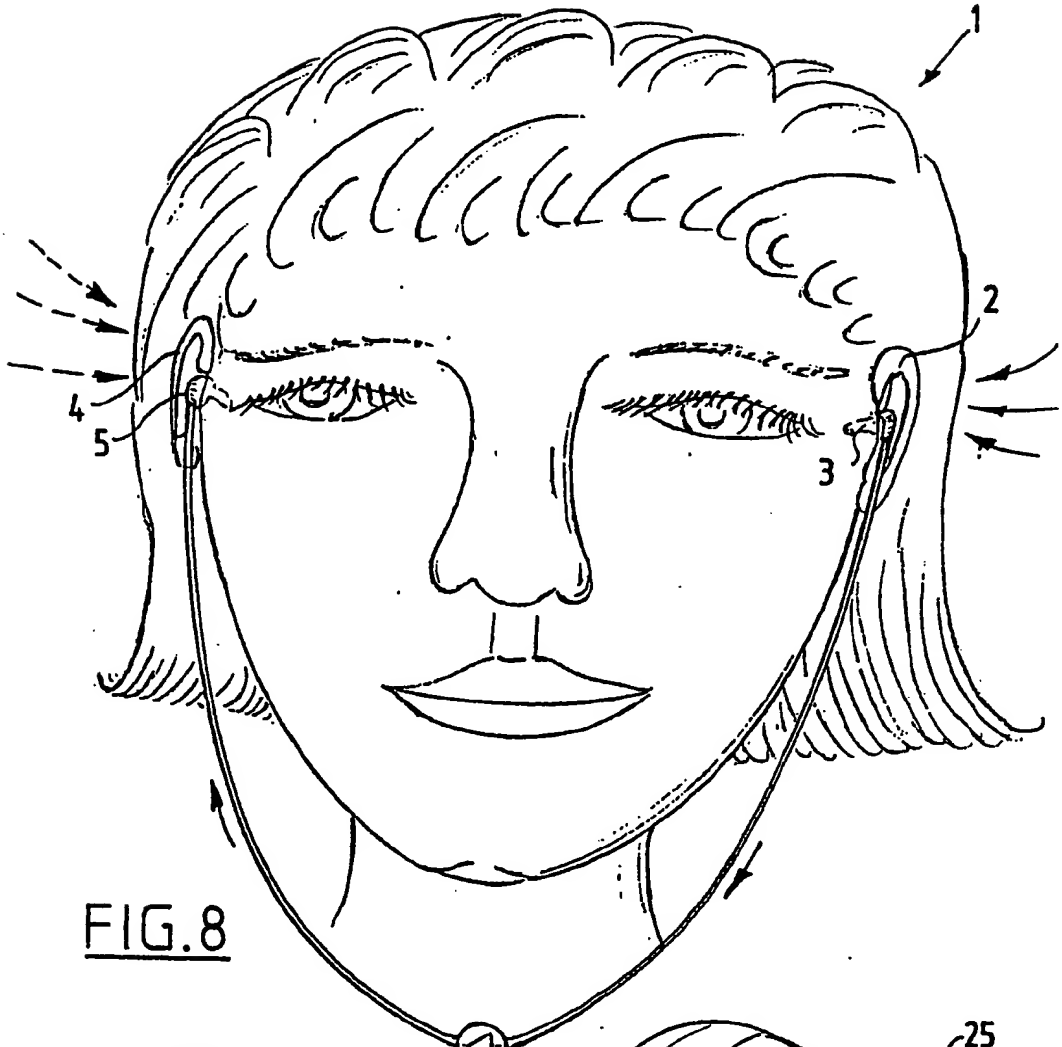

FIG.8

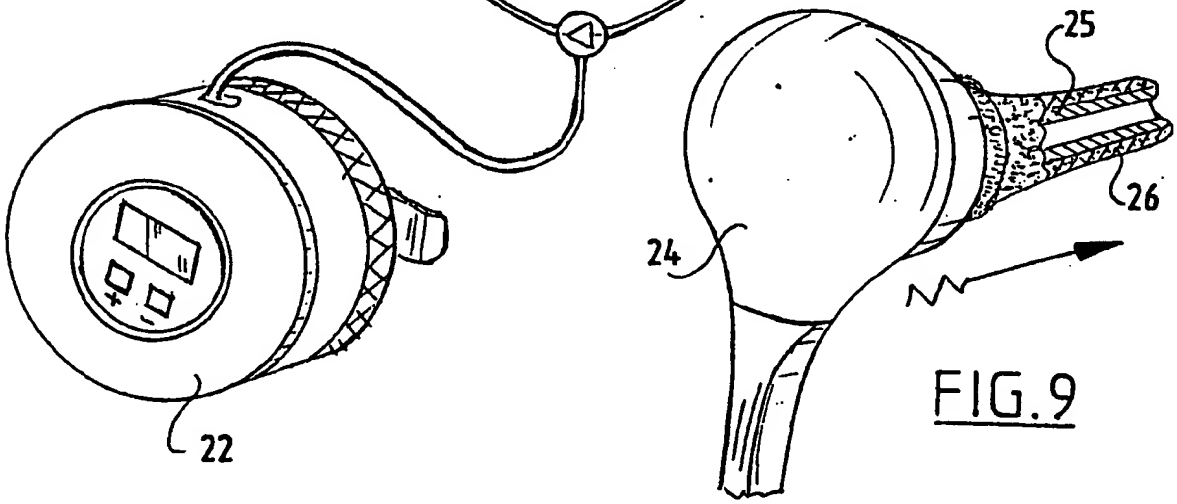

FIG.9

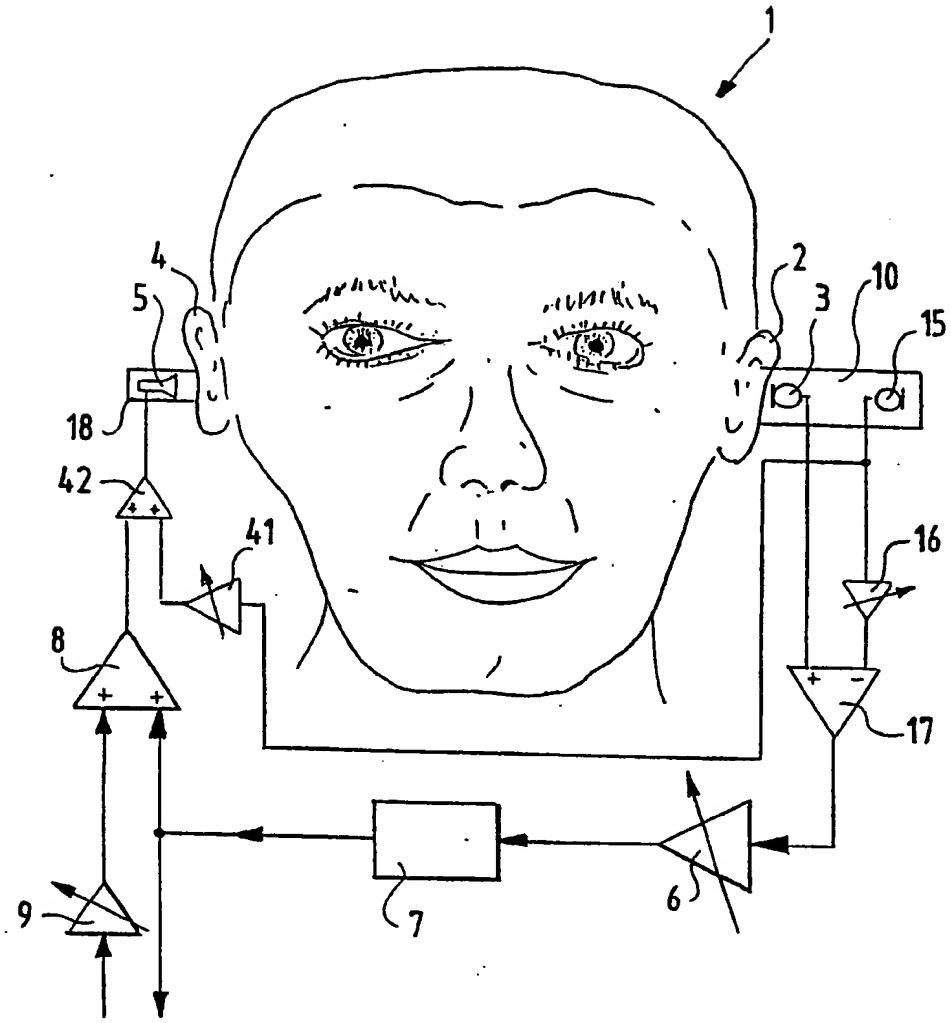

FIG.10

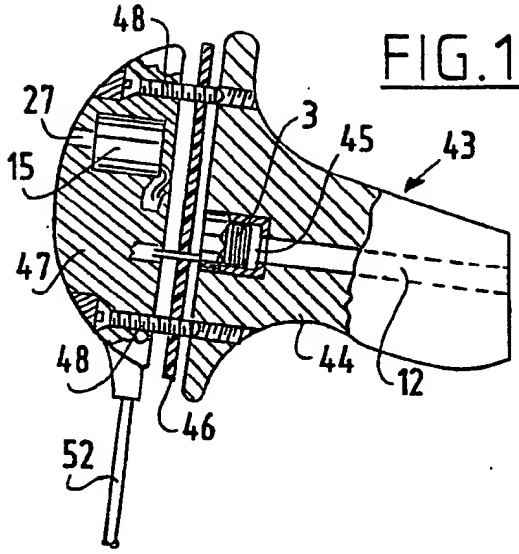

FIG.11

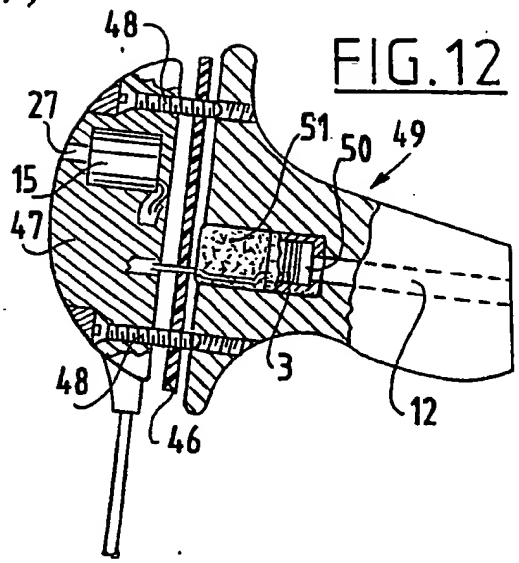

FIG.12

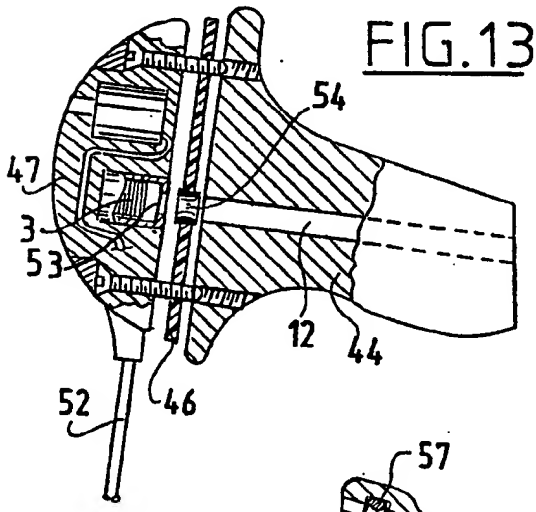

FIG.13

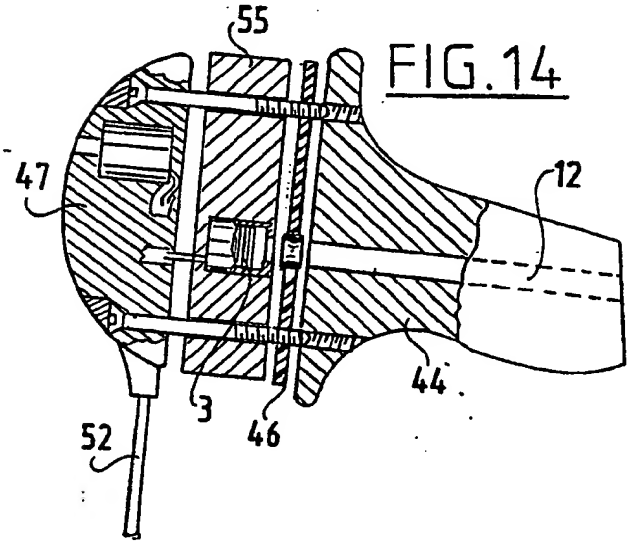

FIG.14

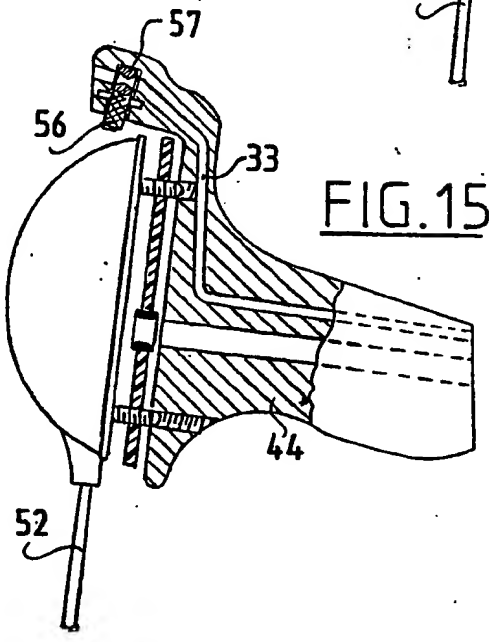

FIG.15

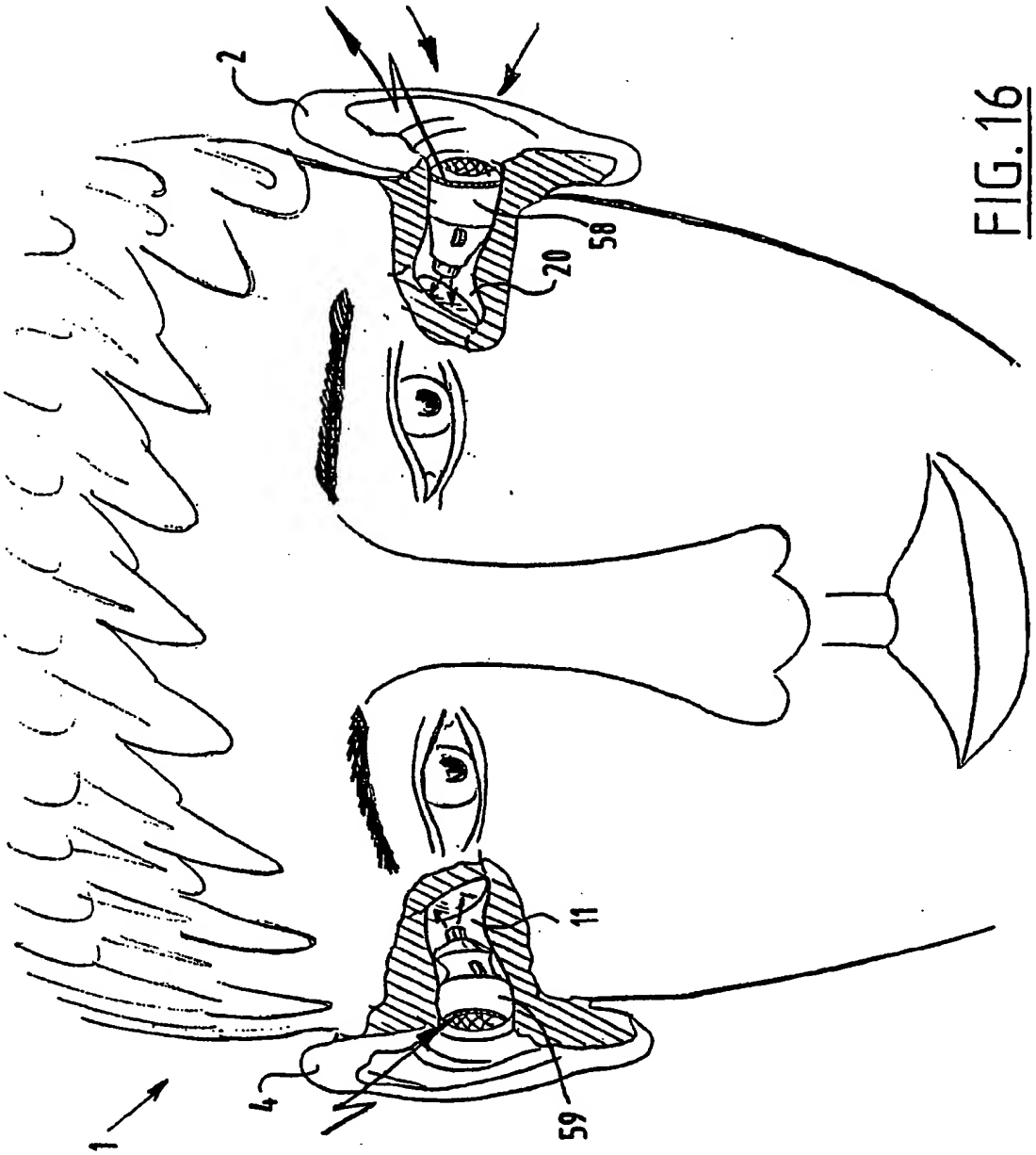

FIG. 16

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 H04R25/00 H04B1/38 H04R1/46 H04M1/05

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 H04R H04B H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,4 654 883 (IWATA) 31 March 1987 see column 2, line 25 - column 3, line 29; figures	1,5-7
X	PATENT ABSTRACTS OF JAPAN vol. 7, no. 276 (E-215)9 December 1983 & JP,A,58 156 233 (PILOT PEN KK) 17 September 1983 see abstract	1,5-7
A	DE,A,19 60 963 (AMERICAN DANISH OTICON A/S) 30 July 1970 see claims; figures	1,8
A	DE,A,39 08 673 (OTICON A/S) 28 September 1989 see claims; figures	2,9

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 February 1994	15. 03. 94
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Authorized officer Gastaldi, G

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP,A,0 092 822 (KONOMI) 2 November 1983 see claims; figures	1,15,16

3

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-4654883	31-03-87	NONE		
DE-A-1960963	30-07-70	GB-A-	1297914	29-11-72
		NL-A-	6918230	09-06-70
DE-A-3908673	28-09-89	US-A-	5033090	16-07-91
EP-A-0092822	02-11-83	JP-C-	1514529	24-08-89
		JP-A-	58188993	04-11-83
		JP-B-	63062954	05-12-88
		JP-C-	1635803	31-01-92
		JP-A-	58188994	04-11-83
		JP-B-	63028557	08-06-88
		JP-C-	1776804	28-07-93
		JP-A-	58188995	04-11-83
		JP-B-	63028558	08-06-88
		JP-C-	1514530	24-08-89
		JP-A-	58188996	04-11-83
		JP-B-	63062955	05-12-88
		JP-C-	1635804	31-01-92
		JP-A-	58188997	04-11-83
		JP-B-	63028559	08-06-88
		JP-C-	1514531	24-08-89
		JP-A-	58210792	08-12-83
		JP-B-	63062956	05-12-88
		JP-C-	1635805	31-01-92
		JP-A-	58210793	08-12-83
		JP-B-	63028560	08-06-88
		AU-B-	552358	29-05-86
		AU-A-	1385983	03-11-83
		US-A-	4588867	13-05-86